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(71)出願人

000002897

大日本印刷株式会社

東京都新宿区市谷北町一丁目 1 番 1 号

(72)発明者

八木 裕

東京都新宿区市谷北町一丁目 1 番 1 号

大日本印刷株式会社内

(73)発明者

森田 通彦

東京都新宿区市谷北町一丁目 1 番 1 号

大日本印刷株式会社内

(74)代理人

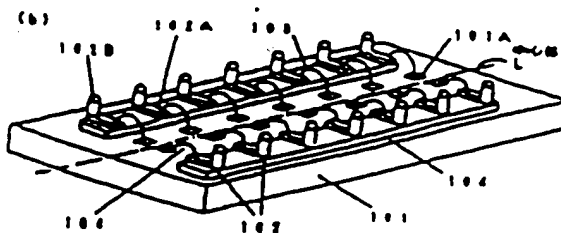
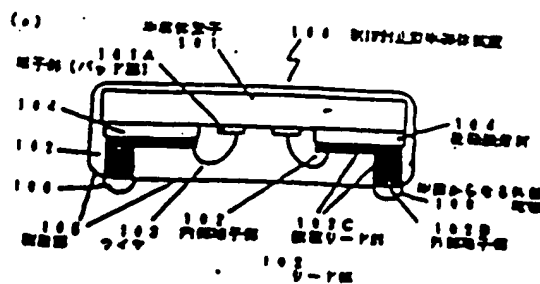
弁護士 小西 修典

(54) [発明の名称] 絶縁防止型半導体装置とそれに用いられるリードフレーム、及び絶縁防止型半導体装置の製造方法

(57) [要約]

【目的】 更なる絶縁防止型半導体装置の高集積化、高信頼化が求められている中、半導体装置パッケージサイズにおけるチップの占有率を上げ、半導体装置の小型化に対応させ、同時に従来の T S O P 等の小型パッケージに懸念であった更なる多ピン化を実現した絶縁防止型半導体装置を提供する。

【構成】 半導体装置の端子側の面に、半導体装置の端子と電気的に接続するための内部端子部と、半導体装置の端子側の面へ突出して外部へと向く外部端子部への接続のための外部端子部と、前記内部端子部と外部端子部とを接続する接続リード部とを一体とした装置のリード部とを、絶縁性材料層を介して、覆着して設けており、且つ、図解基板等への実装のための半田からなる外部電極を前記装置の各リードの外周端子部に連結させ、少なくとも前記半田からなる外部電極の一部は装置部より外部に突出させて設けている。



## 【図 1 の説明】

(請求項 1) 本発明の半導体装置は、半導体素子の端子と電気的に接続するための内部端子部と、半導体素子の端子部の面へ電気的に接続して外部へと向く外部端子部への接続のための外部端子部と、前記内部端子部と外部端子部とを接続する接続リード部とを一体としたリード部を有する。前記外部端子部を介して、外部へと向く。且つ、図 1 の半導体装置への電気的な接続のための外部端子部を前記外部端子部のリード部と接続させ、少なくとも前記外部端子部からなる外部端子部の一部は外部端子部からなる外部端子部の一部に外部端子部より外部へと向くように設けられていることを特徴とする半導体装置。

(請求項 2) 請求項 1 において、半導体素子の端子は半導体素子の端子部の一部の辺の端中心部上に設けられており、リード部は複数の端子を有するように対向し前記一部の一部に設けられていることを特徴とする半導体装置。

(請求項 3) 本発明の半導体装置は、半導体素子の端子と電気的に接続するための内部端子部と、外部端子部と接続するための外部端子部と、前記内部端子部と外部端子部とを接続する接続リード部とを一体とし、外部端子部を、接続リード部を介して、リードフレーム面から電気的に接続する一方の面に突出させ、対向し外部端子部と接続部を介して接続する一方の内部端子部を有する。且つ、各外部端子部のうち、接続リード部と接続し、一体として全体を保持する外部端子部を有していることを特徴とするリードフレーム。

(請求項 4) 本発明の半導体装置は、半導体素子の端子と電気的に接続するための内部端子部と、半導体素子の端子部の面へ電気的に接続して外部へと向く外部端子部への接続のための外部端子部と、前記内部端子部と外部端子部とを接続する接続リード部とを一体としたリード部とを有する。前記外部端子部を介して、外部へと向く。且つ、図 1 の半導体装置への電気的な接続のための外部端子部を前記外部端子部のリード部と接続させ、少なくとも前記外部端子部からなる外部端子部の一部は外部端子部より外部へと向くように設けられている。前記外部端子部のうち、接続リード部と接続し、一体として全体を保持する外部端子部を有していることを特徴とする半導体装置。 (A) エッチング加工で、半導体素子の端子と電気的に接続するための内部端子部と、外部端子部と接続するための外部端子部と、外部端子部と外部端子部とを接続する接続リード部とを一体とし、外部端子部を、接続リード部を介して、リードフレーム面から電気的に接続する一方の面に突出させ、対向し外部端子部と接続部を介して接続する一方の内部端子部を有する。且つ、各外部端子部のうち、接続リード部と接続し、一体として全体を保持する外部端子部を有していることを特徴とする半導体装置。 (B) リードフレームの外側端子部側でない面（裏面）に材料を設け、打ち込み金型により、内側の内部端子部を接続する接続部と外部端子部とを有する半導体装置。

けられた接続部とを有する。リードフレームの打ち込みされた部分が半導体素子の端子部にくるようにして、外部端子部を介して、リードフレーム全面を半導体素子へ接続する工程。 (C) リードフレームの外側端子部を含む部分の打ち込み金型により、打ち込みする工程。

(D) 半導体素子の端子部と、打ち込みで、半導体素子へ接続された内部端子部の接続部とをワイヤボンディングした後に、接続により外部端子部のみを外部へと突出させて全体を接続する工程。 (E) 前記外部端子部からなる外部端子部を半導体素子からなる外部端子部を有する工程。とを含むことを特徴とする半導体装置の製造方法。

## 【発明の詳細な説明】

## 【0001】

【産業上の利用分野】 本発明は、半導体素子を有する半導体装置の半導体装置（プラスチックパッケージ）に、特に、高集積度を向上させ、且つ、多ピン化に対応できる半導体装置とその製造方法に関する。

## 【0002】

(技術的背景) 近年、半導体装置は、高集積化、小型化、低コスト化と電子機器の高性能化と省資源化の傾向（時代）から、LSI の ASIC に代替されるように、ますます高集積化、高性能化になってきている。これに伴い、リードフレームを用いた半導体装置プラスチックパッケージにおいても、その集積のトレンドが、SOJ (Small Outline J-Lead Package) や QFP (Quad Flat Package) のような高集積型のパッケージを経て、TSOP (Thin Small Outline Package) の集積による高集積化を主としたパッケージの小型化へ、さらにはパッケージ内部の 3 次元化によるチップ収容効率向上を目的とした LOC (Lead On Chip) の集積へと進展して来た。しかし、高集積型半導体装置パッケージには、高集積化、高性能化とともに、更に一層の多ピン化、高集積化、小型化が求められており、上記従来のパッケージにおいてもチップ外周部分のリードの引き出しがあるため、パッケージの小型化に限界が見えて来た。また、TSOP 等の小型パッケージにおいては、リードの引き出し、ピンピッチから多ピン化に対しても限界が見えて来た。

## 【0003】

【発明が解決しようとする課題】 上記のように、従来の高集積型半導体装置の高集積化、高性能化が求められており、高集積型半導体装置パッケージの一層の多ピン化、高集積化、小型化が求められている。本発明は、このような状況のもと、半導体装置パッケージサイズにおけるチップの占有率を上げ、半導体装置の小型化に対応させ、図 1 の半導体装置を製造できる。即ち、図 1 の半導体装置を製造しようとするものである。また、図 1

に従来の T S O P 系の小型パッケージに搭載であった更なる多ピン化を實現しようとするものである。

( 0 0 0 4 )

( 注記を省略するための手段 ) 本発明の絶縁防止型半導体装置は、半導体素子の端子側の面に、半導体素子の端子と電気的に接続するための内部端子部と、半導体素子の端子側の面へ直交して外部へと向く外部端子部への接続のための外部端子部と、前記内部端子部と外部端子部とを連結する接続リード部とを一体とした複数のリード部とを、絶縁層材料層を介して、露出して設けており、且つ、図解基板上への実装のための半田からなる外部電極を前記複数の各リードの外部端子部に導通させ、少なくとも前記半田からなる外部電極の一部は絶縁層より外部に突出させて設けていることを特徴とするものである。尚、上記において、内部端子部と外部端子部とを一体とした複数のリード部の配列を半導体素子の端子側面に二次元的に配列し、外部端子部を半田ボールにて形成することにより B C A ( B a i l - G r i d - A r r a y ) タイプの絶縁防止型半導体装置とすることとする。

( 0 0 0 5 ) そして、上記において、半導体素子の端子は半導体素子の端子側の面の一列の辺の端中心部上に設けて設けられており、リード部は複数の端子を挟むように対向し前記一列の辺に沿い設けられていることを特徴とするものである。また、本発明のリードフレームは、絶縁防止型半導体装置用のリードフレームであって、半導体素子の端子と電気的に接続するための内部端子部と、外部端子部とを連結するための外部端子部と、前記内部端子部と外部端子部とを連結する接続リード部とを一体とし、該外部端子部を、接続リード部を介して、リードフレーム面から突出する一方の側に突出させ、対向し先端部同士で接続部を介して接続する一方の内部端子部を形成設けており、且つ、各外部端子部の外側で、接続リード部と導通し、一体として全体を保持する外部部を設けていることを特徴とするものである。尚、上記リードフレームにおいて、内部端子部と外部端子部とそれとを連結する接続リード部とを一体とした複数を接続リードフレーム面に二次元的に配列するして形成することにより B C A ( B a i l - G r i d - A r r a y ) タイプの絶縁防止型半導体装置用のリードフレームとすることとする。

( 0 0 0 6 ) 本発明の絶縁防止型半導体装置の製造方法は、半導体素子の端子側の面に、半導体素子の端子と電気的に接続するための内部端子部と、半導体素子の端子側の面へ直交して外部へと向く外部端子部への接続のための外部端子部と、前記内部端子部と外部端子部とを連結する接続リード部とを一体とした複数のリード部とを、絶縁層材料層を介して、露出して設けており、且つ、図解基板上への実装のための半田からなる外部電極を前記複数の各リードの外部端子部に導通させ、少なくとも前記半田からなる外部電極の一部は絶縁層より外部に突出させて設けていることを特徴とするものである。尚、上記において、内部端子部と外部端子部とを一体とした複数のリード部の配列を半導体素子の端子側面に二次元的に配列し、外部端子部を半田ボールにて形成することにより B C A ( B a i l - G r i d - A r r a y ) タイプの絶縁防止型半導体装置とすることとする。

図解基板上への実装のための半田からなる外部電極を前記複数の各リードの外部端子部に導通させ、少なくとも前記半田からなる外部電極の一部は絶縁層より外部に突出させて設けていることを特徴とするものである。尚、上記において、内部端子部と外部端子部とを一体とした複数のリード部の配列を半導体素子の端子側面に二次元的に配列し、外部端子部を半田ボールにて形成することにより B C A ( B a i l - G r i d - A r r a y ) タイプの絶縁防止型半導体装置とすることとする。

( 0 0 0 7 )

( 作用 ) 本発明の絶縁防止型半導体装置は、上記のような構成にすることにより、半導体装置パッケージタイプにおけるチップの占率を上げ、半導体装置の小型化に対応できるものとしている。即ち、半導体装置の図解基板への実装密度を低減し、図解基板への実装密度の向上を可能としている。詳しくは、内部端子部、外部端子部とを一体とした複数のリード部を半導体素子面に絶縁層材料層を介して露出し、前記外部端子部に半田からなる外部電極を導通させていることより、装置の小型化を達成している。そして、上記半田からなる外部電極部を、半導体素子面に導通可能な形で二次元的に配列することにより、半導体装置の多ピン化を可能としている。半田からなる外部電極部を半田ボールとし、二次元的には外部電極部を配列した場合には B C A タイプとなり、半導体装置の多ピン化にも対応できる。また、上記において、半導体素子の端子が半導体素子の端子側の面の一列の辺の端中心部上に設けて設けられ、リード部は複数の端子を挟むように対向し前記一列の辺に沿って設けられており、装置の製造とし、量産性に適した構造としている。本発明のリードフレームは、上記のような構成にすることにより、上記絶縁防止型半導体装置の製造を可能とするものであるが、通常のリードフレームと同様のエッチング工程を経て製造される。

とがてら、本発明の製造方法及び本発明の製造装置は、上記リードフレームを用いて、リードフレームの外周部を形成する面（下面）に地金層を形成し、行ははを金装により、方向する内部端子部同士を接続する導線部と導線部に対応する位置に設けられた地金層とを形成し、リードフレームの形成された部分が半導体素子の端子部にくるようにして、製造装置を介して、リードフレーム全体を半導体素子へ搭載し、リードフレームの外周部を含む半導体素子の部分を形成し、金装により切断することにより、内部端子と外部端子を一体化した組み立て半導体素子上に形成した。本発明の、半導体素子の小型化が可能で、且つ、多ピン化が可能で、新規製造型半導体素子の作成が可能としている。

(0008)

(実施例) 本発明の製造方法及び本発明の製造装置を以下、図にそって説明する。図1(a)は本発明の製造型半導体素子の断面図であり、図1(b)は上面図である。図1中、100は製造型半導体素子、101は半導体素子、102はリード部、102Aは内部端子部、102Bは外部端子部、102Cは形成リード部、101Aは端子部（パッド部）、103はワイヤ、104は地金層、105は製造部、106は半導体（ペースト）からなる外部端子部である。本発明の製造型半導体素子は、上述するリードフレームを用いたもので、内部端子部102A、外部端子部102Bを一体化した半導体のリード部102を多量半導体素子101上に地金層104を介して形成し、且つ、外部端子部102B先に半導体からなる外部端子部106より外部へ突出させて設けた。パッケージ性が半導体素子の面性に付随する製造型半導体素子であり、図1(a)に示すように、半導体素子101の端子部（パッド部）101Aは半導体素子の中心部とはずらして2箇所、中心部101に附して設けられており、リード部102は、内部端子部102Aが形成端子部（パッド部）に附した位置に半導体素子101の面の外側に中心部を向き対向するように設けられている。外部端子部102Bは内部端子部102Aから形成リード部102Cを介して附して設けられ、ほぼ半導体素子の断面までに達した位置で半導体素子面に突出する方向に、形成リード102Cがしずかに金装し、外部端子部102Bはその先に位置し、半導体素子の面に平行な方向で一元的に配列をしている。即ち、中心部101を挟み2列の外部端子部102Bの配列を設けている。そして、8列の外部端子部102Bを形成し、半導体（ペースト）からなる外部端子部106を形成部105より外部に突出させて設けている。1. 地金層104としては、100μm厚のポリイ

とを形成したが、他には、シリコンエポキシ樹脂（TA1715（住友ベークライト株式会社）や硬化剤（硬化剤HC5200（住友ベークライト株式会社））等が用いられる。上記実施例では、半導体ペーストからなる外部端子部であるが、この部分は半導体ペーストに代えてもよい。尚、本発明の製造型半導体素子は、上記のように、パッケージ性が半導体素子の面性に付随する、面性に小型化されたパッケージであるが、その方向について、1. 0mm以下にすることができ、厚さ10mmに達してはならない。本発明においては、外部端子部（パッド部）に約2列に配列したが、半導体素子の端子部の位置を二次元的に配列し、内部端子部と外部端子部との一体化した組み立て半導体素子の端子部に二次元的に配列して形成することにより、半導体素子の、一層の多ピン化に十分対応できる。

(0009) 以下、本発明のリードフレームの実施例を説明し、図にそって説明する。本発明のリードフレームは、上記実施例半導体素子に用いられたものである。図2は本発明のリードフレームの断面図を示すもので、図2中、200はリードフレーム、201は内部端子部、202は外部端子部、203は形成リード部、204は地金層、205は外部端子部である。リードフレームは42合金（Ni42%のFe合金）からなり、リードフレームの厚さは、内部端子部のある厚さ部で0.05mm、外部端子部のある厚さ部で0.2mmである。内部端子部の方向する先端部同士を接続する導線部205は厚さ（0.05mm厚）に形成されており、上述する半導体素子を形成する際の行ははを金装にて行ははとし、金装部となっている。本発明では外部端子部202は丸状であるが、これに限定はされない。また、リードフレーム200として42合金を用いたがこれに限定されない。42合金でもよい。

(0010) 次に、上記実施例リードフレームの製造方法を図を用いて簡単に説明する。図4は本発明のリードフレームを製造した工程を示したものである。先ず、42合金（Ni42%のFe合金）からなる、厚さ0.2mmのリードフレーム原料300を準備し、板の両面を研磨を行い、表面を平滑化した（図3(a)）は、リードフレーム原料300の両面に感光性のレジスト301を塗布し、乾燥した。（図3(b)）。

次に、リードフレーム原料300の両面から所定のパターンを用いてレジストの所定の部分のみに露光を行った。露光後、レジストパターン301Aを形成した。（図3(c)）

露光レジストとしては、感光性樹脂（PMEレジスト）を使用した。次に、レジストパターン301Aを形成後、57°C、48時間の硬化処理（熱硬化）にて、リードフレーム原料300の両面からスプレイングして、外部端子

の平直部が図2に示されるリードフレームを形成した(図3(c))。図2(b)のは、図2(a)～(c)における平直部である。これは、レジストを形成した後、蝕刻処理を施した後、所定の箇所(内部端子部分を含む領域)のみに金メッキ処理を行った。(図3(e))  
尚、上記リードフレームの製造工程においては、図2(b)に示すように、厚肉部と薄肉部を形成するため、外装面形成面からのエッチング(露出)を多く行い、反対面側からは少なめにエッチング(露出)を行った。また、金メッキに代り、銀メッキやパラジウムメッキでもよい。上記のリードフレームの製造方法は、1ヶの半導体装置を形成するために必要なリードフレーム1ヶの製造方法であるが、通常は多数の面から、リードフレーム部材をエッチング加工する後、図2に示すリードフレームを複数面付けした状態で作製し、上記の工程を行う。この場合は、図2に示す外装部205の一部に露出する領域(図示していない)をリードフレームの外側に付けて配付け状態とする。

(0011)次に、上記のようにして作製されたリードフレームを用いた、本発明の密封型半導体装置の製造方法の実施例を図に示して説明する。図4は、本発明の密封型半導体装置の製造工程を示すものである。図3に示すようにして作製されたリードフレーム400の外装端子部402形成部(図面)と対向する裏面に、ポリイミド系熱硬化型の絶縁性材料(テープ)401(日立化成株式会社製、HMJ22C)を、400°C、6Kg/m<sup>2</sup>で1.0秒間圧着して貼りつけた(図4(a))。この状態の平面図を図5に示す。この後打ち抜き金型405A、405Bにて(図4(b))、対向する内部端子部の先端部を露出する露出部403と、その部分の絶縁性材料(テープ)401とを打ち抜いた。(図4(c))  
次いで、外装打ち抜きおよび圧着金型406A、406Bを用い、外装部404を含む不要部分を切り除す(図4(d))と同時に、絶縁性材料404を介して半導体素子407上にリード部408の圧着を行った。(図4(e))

尚、この図4(d)に示す、所定リードと露出してリードフレーム全体を支えている外装部204を含む不要部分を切り除しは、露出部403に付してもよい。この場合には、通常の本用リードフレームを用いたQFPパッケージ等のようにダムバー(図示していない)を設けるとよい。リード部410を半導体素子411へ接続した後、ワイヤ414により、半導体素子の端子(パッド)411Aとリード部410の内部端子410Aとを電気的に結着した。(図4(f))  
その後、所定の金型を用い、エポキシ系の樹脂415でリード部410の外装端子部410Bのみを固定させ、全体を封止した。(図4(g))

ここでは、導用の金型(図示していない)を用いたが、

所定の面(外装端子部)を露出部403に止めた後、エッチング処理を必要としない。次いで、露出されている外装端子部410B上に半導体素子をスクリーン印刷により塗布し、半田(ペースト)からなる外装端子部416を作製し、本発明の密封型半導体装置を作製した。(図4(h))

尚、半田からなる外装端子部416の作製は、スクリーン印刷に限定されるものではなく、リフローまたはポッティング等でも、図4(e)と半田は必要との状態に必要量の半田が得られればよい。

(0012)

(発明の効果)本発明は、上記のように、更なる密封型半導体装置の高集積化、高信頼化が求められる状況のもと、半導体装置パッケージサイズにおけるチップの占有部を上げ、半導体装置の小型化に対応させ、図4(e)への実装部を低減できる。即ち、図4(e)への実装部を向上させることができる半導体装置の提供を可能としたものであり、同時に従来のTSOP等の小型パッケージに適用であった更なる多ピン化を実現した密封型半導体装置の提供を可能としたものである。

(図面の簡単な説明)

(図1)本発明の密封型半導体装置の概略図面及び断面図

(図2)本発明のリードフレームの平面図

(図3)本発明のリードフレームの製造工程図

(図4)本発明の密封型半導体装置の製造工程図

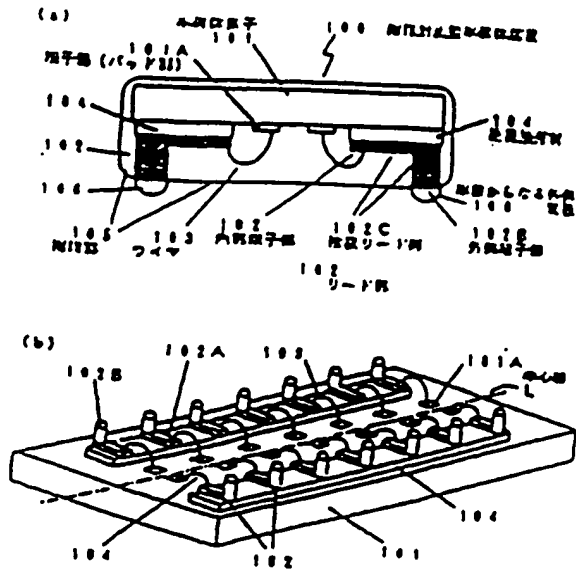
(図5)本発明のリードフレームに絶縁性材料を貼り付けた状態の平面図

(符号の説明)

100	密封型半導体装置
101	半導体素子
101A	端子部(パッド部)
102	リード部
102A	内部端子部
102B	外装端子部
102C	形成リード部
103	ワイヤ
104	絶縁性材料
105	樹脂部
106	半田(ペースト)からなる外装
200	リードフレーム
201	内部端子部
202	外装端子部
203	形成リード部
204	露出部
205	外装部
300	リードフレーム部材
301	レジスト

303A 内装端子部  
 303B 外装端子部  
 304 送信部  
 305 受メッキ部  
 306 外装部  
 400 リードフレーム  
 401 絶縁性材料 (テープ)  
 402 外装端子部  
 403 送信部

(図1)

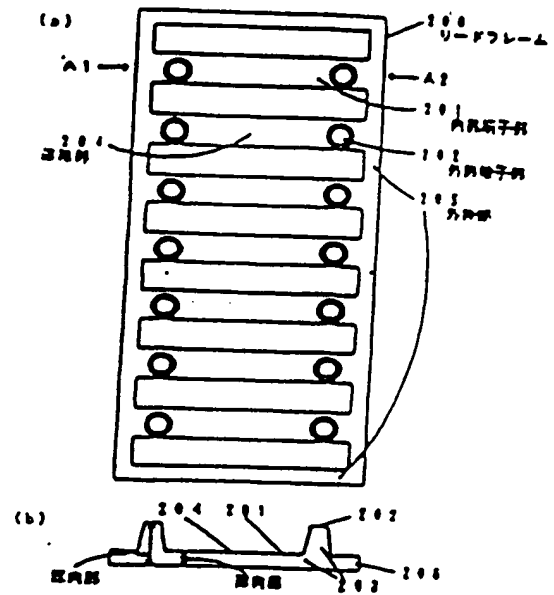


(16)

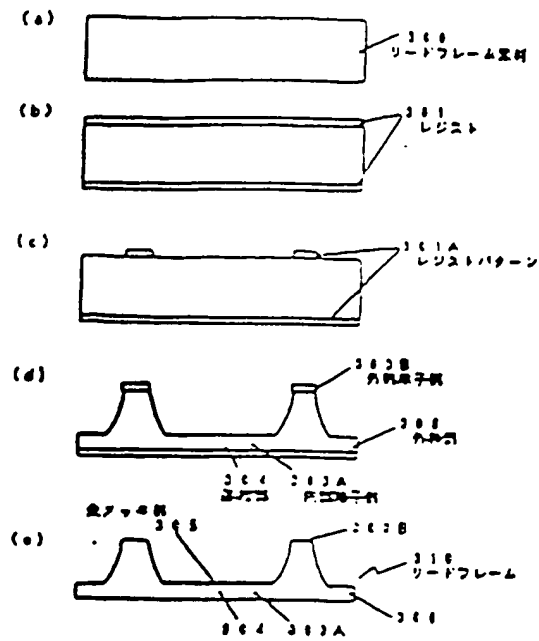
特開平8-25066

405A, 405B 17ちび2金型  
 406A, 406B 外装17ちび2および17ちび2金型  
 410 リード部  
 410A 内装端子部  
 410B 外装端子部  
 410C 接触リード部  
 411 本通作端子  
 411A ワイヤ  
 415 板厚

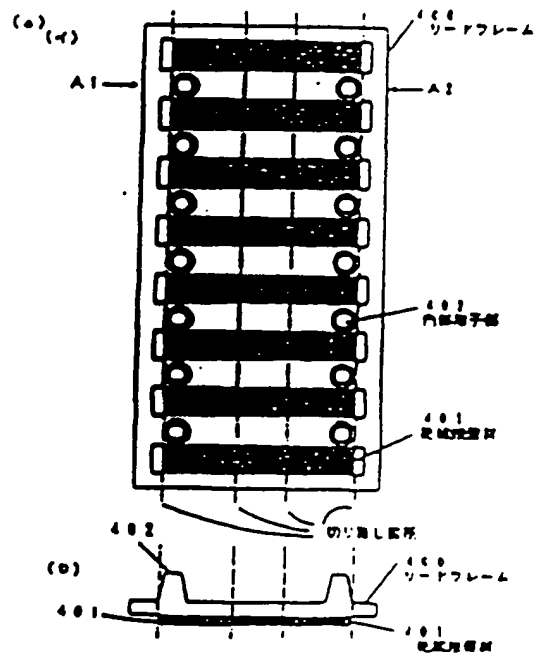
(図2)



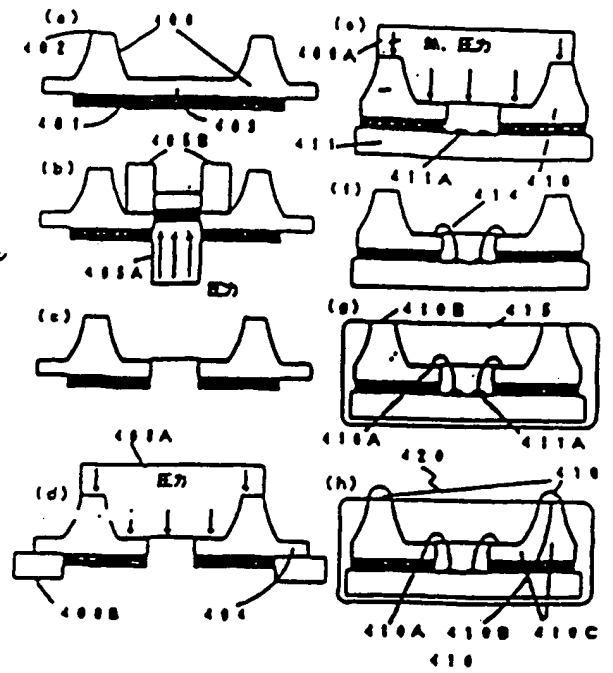
( 図 3 )



( 図 5 )



( 図 4 )



## Japanese Patent Laid-Open Publication No. Heisei 8-125066

## [TITLE OF THE INVENTION]

Resin Encapsulated Semiconductor Device, Lead Frame  
5 Used Therein, and Fabrication Method for the Resin  
Encapsulated Semiconductor Device

## [CLAIMS]

1. A resin encapsulated semiconductor device  
10 comprising:

a semiconductor chip;

a plurality of leads fixedly attached to a terminal-  
end surface of the semiconductor chip by an insulating  
adhesive interposed between the semiconductor chip and the  
15 leads, each of the leads including integral portions, that  
is, an inner terminal portion adapted to be electrically  
connected to an associated one of terminals of the  
semiconductor chip, an outer terminal portion extending  
outwardly in a direction orthogonal to the terminal-end  
20 surface of the semiconductor chip and adapted to be  
connected to an external circuit, and a connecting lead  
portion adapted to connect the inner and outer terminal  
portions to each other; and

outer electrodes each connected to the outer terminal  
25 portion of an associated one of the leads and made of



solder to allow the semiconductor device to be mounted on a circuit board, at least a part of the outer leads being externally exposed from a resin encapsulate.

5           2. The resin encapsulated semiconductor device according to claim 1, wherein the terminals of the semiconductor chip are arranged along a substantially center line between a pair of sides of the semiconductor chip on the terminal-end surface of the semiconductor chip,  
10       and the leads are arranged in two facing sets along the sides of the semiconductor chip, respectively, in such a fashion that the terminals of the semiconductor chip are interposed between the two facing lead sets.

15           3. A lead frame comprising:

          a plurality of leads each including integral portions, that is, an inner terminal portion adapted to be electrically connected to an associated one of terminals of a semiconductor chip, an outer terminal portion adapted to  
20       be connected to an associated one of terminals of an external circuit, and a connecting lead portion adapted to connect the inner and outer terminal portions to each other;

          each of the outer terminal portions of the leads  
25       being protruded in a direction orthogonal to a lead frame

surface via an associated one of the connecting lead portions;

the inner lead portions of the leads being arranged in pair in such a fashion that the leads of each lead pair have facing tips, respectively;

connecting portions each adapted to connect the facing tips of the leads included in an associated one of the lead pairs; and

an outer frame portion arranged outside the outer terminal portions and connected to the connecting lead portions in such a fashion that they form an integral structure together, thereby protecting the entire portion of the lead frame.

4. A method for fabricating a semiconductor device including a semiconductor chip, a plurality of leads fixedly attached to a terminal-end surface of the semiconductor chip by an insulating adhesive-interposed between the semiconductor chip and the leads, each of the leads including integral portions, that is, an inner terminal portion adapted to be electrically connected to an associated one of terminals of the semiconductor chip, an outer terminal portion extending outwardly in a direction orthogonal to the terminal-end surface of the semiconductor chip and adapted to be connected to an external circuit,

and a connecting lead portion adapted to connect the inner and outer terminal portions to each other; and outer electrodes each connected to the outer terminal portion of an associated one of the leads and made of solder to allow  
5 the semiconductor device to be mounted on a circuit board, at least a part of the outer leads being externally exposed from a resin encapsulate, comprising the steps of:

(A) fabricating a lead frame including a plurality of leads each including integral portions, that is, an inner  
10 terminal portion adapted to be electrically connected to an associated one of terminals of a semiconductor chip, an outer terminal portion adapted to be connected to an associated one of terminals of an external circuit, and a connecting lead portion adapted to connect the inner and  
15 outer terminal portions to each other, each of the outer terminal portions of the leads being protruded in a direction orthogonal to a lead frame surface via an associated one of the connecting lead portions, the inner lead portions of the leads being arranged in pair in such a  
20 fashion that the leads of each lead pair have facing tips, respectively, connecting portions each adapted to connect the facing tips of the leads included in an associated one of the lead pairs, and an outer frame portion arranged outside the outer terminal portions and connected to the  
25 connecting lead portions in such a fashion that they form

an integral structure together, thereby protecting the entire portion of the lead frame;

(B) applying an insulating layer to a surface of the lead frame opposite to the outer terminal portions, punching out the connecting portions adapted to connect facing ones of the inner lead portions to each other along with portions of the insulating layer respectively arranged at regions corresponding to the connecting portions by use of punching dies, aligning the punched portions of the lead frame with the terminals of the semiconductor chip, and mounting the entire portion of the lead frame on the semiconductor chip by the adhesive interposed therebetween;

(C) cutting off unnecessary portions of the lead frame including the outer frame portion by use of punching dies, thereby removing the cut-off portions;

(D) wire-bonding the terminals of the semiconductor chip with tips of the inner terminal portions mounted on the semiconductor chip, and encapsulating the semiconductor chip and the lead frame by a resin while allowing a surface of the lead frame toward the outer terminal portions to be externally exposed; and

(E) forming outer electrodes made of solder on the exposed lead frame surface toward the outer terminal portions.

## [DETAILED DESCRIPTION OF THE INVENTION]

## [FIELD OF THE INVENTION]

The present invention relates to a resin encapsulated semiconductor device (plastic package) in which a semiconductor chip is packaged, and more particularly to a semiconductor device configured to achieve an improvement in mounting density or to have a multi-pinned structure and a method for manufacturing such a semiconductor device.

## 10 [DESCRIPTION OF THE PRIOR ART]

Recently, semiconductor devices have been developed to have a higher integration degree and a higher performance by virtue of developments of techniques associated with an increase in integration degree and miniaturization and in pace with the tendency of electronic appliances to have a high performance and a light, thin, simple, and miniature structure. A representative example of such semiconductor devices is an ASIC of LSI. For instance, developments of resin encapsulated semiconductor device plastic packages have been advanced from surface-mounting packages such as SOJs (Small Outlined-Leaded Packages) or QFPs (Quad Flat Packages) to packages having a miniature structure mainly achieved in accordance with a thinness obtained by virtue of developments of TSOPs (Thin Small Outline Packages) or to LOC (Lead On Chip) structures

adapted to achieve an improvement in the chip packaging efficiency by virtue of developments of an internal three-dimensional package structure. In addition to an increase in integration degree and improvement in performance, there has also been growing demand for an increase in the number of pins, thickness, and miniaturization of resin encapsulated semiconductor packages. In the above mentioned conventional packages, however, there is a limitation in miniaturization because those packages have a structure in which leads are arranged around a chip. Similarly, leads are arranged around a chip in the case of miniature packages such as TSOPs. In such packages, there is also a limitation in increasing the number of pins due to the pin pitch used.

[SUBJECT MATTERS TO BE SOLVED BY THE INVENTION]

As mentioned above, there has been demand for an increase in integration degree and improvement in performance of resin encapsulated semiconductor devices. Also, there has also been growing demand for an increase in the number of pins, thickness, and miniaturization of resin encapsulated semiconductor packages. In such situations, the present invention makes it possible to increase the occupancy degree of a chip in a semiconductor package with a limited size while reducing the mounting area of the

semiconductor package on a circuit board to achieve a miniaturization of the resulting semiconductor device. That is, the present invention is adapted to provide a resin encapsulated semiconductor device capable of achieving an improvement in the mounting density thereof on a circuit board. Also, the present invention is adapted to achieve an increase in the number of pins which is difficult in miniature packages such as conventional TSOPs.

10 [MEANS FOR SOLVING THE SUBJECT MATTERS]

The resin encapsulated semiconductor device of the present invention is characterized in that it comprises: a semiconductor chip; a plurality of leads fixedly attached to a terminal-end surface of the semiconductor chip by an insulating adhesive interposed between the semiconductor chip and the leads, each of the leads including integral portions, that is, an inner terminal portion adapted to be electrically connected to an associated one of terminals of the semiconductor chip, an outer terminal portion extending outwardly in a direction orthogonal to the terminal-end surface of the semiconductor chip and adapted to be connected to an external circuit, and a connecting lead portion adapted to connect the inner and outer terminal portions to each other; and outer electrodes each connected to the outer terminal portion of an associated one of the

leads and made of solder to allow the semiconductor device to be mounted on a circuit board, at least a part of the outer leads being externally exposed from a resin encapsulate. The above semiconductor device can be embodied into a BGA (Ball Grid Array) type resin encapsulated semiconductor device by arranging a plurality of leads each having an inner terminal portion and an outer terminal portion integral with each other in a two-dimensional fashion on the terminal-end surface of the semiconductor chip and forming the outer electrodes in the form of solder balls.

The above semiconductor device is also characterized in that the terminals of the semiconductor chip are arranged along a substantially center line between a pair of sides of the semiconductor chip on the terminal-end surface of the semiconductor chip, and the leads are arranged in two facing sets along the sides of the semiconductor chip, respectively, in such a fashion that the terminals of the semiconductor chip are interposed between the two facing lead sets. The lead frame of the present invention is characterized in that it comprises: a plurality of leads each including integral portions, that is, an inner terminal portion adapted to be electrically connected to an associated one of terminals of a semiconductor chip, an outer terminal portion adapted to be



connected to an associated one of terminals of an external circuit, and a connecting lead portion adapted to connect the inner and outer terminal portions to each other; each of the outer terminal portions of the leads being protruded in a direction orthogonal to a lead frame surface via an associated one of the connecting lead portions; the inner lead portions of the leads being arranged in pair in such a fashion that the leads of each lead pair have facing tips, respectively; connecting portions each adapted to connect the facing tips of the leads included in an associated one of the lead pairs; and an outer frame portion arranged outside the outer terminal portions and connected to the connecting lead portions in such a fashion that they form an integral structure together, thereby protecting the entire portion of the lead frame. The above lead frame can be embodied into a lead frame for a BGA (Ball Grid Array) type resin encapsulated semiconductor device by arranging a plurality of leads each having an inner terminal portion and an outer terminal portion integral with each other in a two-dimensional fashion on the terminal-end surface of the semiconductor chip and forming the outer electrodes in the form of solder balls.

The present invention is also characterized by a method for fabricating a semiconductor device including a semiconductor chip, a plurality of leads fixedly attached

to a terminal-end surface of the semiconductor chip by an insulating adhesive interposed between the semiconductor chip and the leads, each of the leads including integral portions, that is, an inner terminal portion adapted to be electrically connected to an associated one of terminals of the semiconductor chip, an outer terminal portion extending outwardly in a direction orthogonal to the terminal-end surface of the semiconductor chip and adapted to be connected to an external circuit, and a connecting lead portion adapted to connect the inner and outer terminal portions to each other; and outer electrodes each connected to the outer terminal portion of an associated one of the leads and made of solder to allow the semiconductor device to be mounted on a circuit board, at least a part of the outer leads being externally exposed from a resin encapsulate, comprising the steps of: (A) fabricating a lead frame including a plurality of leads each including integral portions, that is, an inner terminal portion adapted to be electrically connected to an associated one of terminals of a semiconductor chip, an outer terminal portion adapted to be connected to an associated one of terminals of an external circuit, and a connecting lead portion adapted to connect the inner and outer terminal portions to each other, each of the outer terminal portions of the leads being protruded in a direction orthogonal to a

lead frame surface via an associated one of the connecting lead portions, the inner lead portions of the leads being arranged in pair in such a fashion that the leads of each lead pair have facing tips, respectively, connecting portions each adapted to connect the facing tips of the leads included in an associated one of the lead pairs, and an outer frame portion arranged outside the outer terminal portions and connected to the connecting lead portions in such a fashion that they form an integral structure together, thereby protecting the entire portion of the lead frame; (B) applying an insulating layer to a surface of the lead frame opposite to the outer terminal portions, punching out the connecting portions adapted to connect facing ones of the inner lead portions to each other along with portions of the insulating layer respectively arranged at regions corresponding to the connecting portions by use of punching dies, aligning the punched portions of the lead frame with the terminals of the semiconductor chip, and mounting the entire portion of the lead frame on the semiconductor chip by the adhesive interposed therebetween; (C) cutting off unnecessary portions of the lead frame including the outer frame portion by use of punching dies, thereby removing the cut-off portions; (D) wire-bonding the terminals of the semiconductor chip with tips of the inner terminal portions mounted on the semiconductor chip, and

encapsulating the semiconductor chip and the lead frame by  
a resin while allowing a surface of the lead frame toward  
the outer terminal portions to be externally exposed; and  
(E) forming outer electrodes made of solder on the exposed  
5 lead frame surface toward the outer terminal portions.

[FUNCTIONS]

With the above mentioned configuration, the resin  
encapsulated semiconductor device of the present invention  
10 can increase the occupancy degree of the chip while  
achieving a miniaturization thereof. That is, the resin  
encapsulated semiconductor device is capable of reducing  
the mounting area thereof on a circuit board and achieving  
an improvement in the mounting density thereof on the  
15 circuit board. In particular, the present invention  
achieves a miniaturization of the semiconductor device by  
fixedly attaching a plurality of leads each including an  
inner terminal portion and an outer terminal portion  
integral with each other to a surface of a semiconductor  
20 chip by an insulating adhesive layer interposed between the  
semiconductor chip and the leads, and connecting outer  
electrodes made of solder to the outer terminal portions,  
respectively. Also, the present invention achieves an  
increase in the number of pins in the semiconductor device  
25 by arranging the outer electrodes made of solder in a two-

dimensional fashion on a plane parallel to the surface of the semiconductor chip. Where the outer electrodes made of solder are formed in the form of solder balls and arranged in a two-dimensional fashion, a BGA type semiconductor device capable of achieving an increase in the number of pins can be obtained. In the above semiconductor device, the terminals of the semiconductor chip are arranged along a substantially center line between a pair of sides of the semiconductor chip on the terminal-end surface of the semiconductor chip, and the leads are arranged in two facing sets along the sides of the semiconductor chip, respectively, in such a fashion that the terminals of the semiconductor chip are interposed between the two facing lead sets. Thus, the semiconductor device has a simple structure suitable in regard to productivity. The lead frame of the present invention makes it possible to fabricate the above mentioned resin encapsulated semiconductor device by virtue of there above mentioned configuration thereof. However, this lead frame can be fabricated using a half etching method during an etching process as used for conventional lead frames. The method for fabricating a resin encapsulated semiconductor device in accordance with the present invention involves the steps of applying an insulating layer to a surface of the lead frame opposite to the outer terminal portions, punching out

the connecting portions adapted to connect facing ones of the inner lead portions to each other along with portions of the insulating layer respectively arranged at regions corresponding to the connecting portions by use of punching dies, aligning the punched portions of the lead frame with the terminals of the semiconductor chip, and mounting the entire portion of the lead frame on the semiconductor chip by the adhesive interposed therebetween, and cutting off unnecessary portions of the lead frame including the outer frame portion by use of punching dies, thereby removing the cut-off portions. Thus, a plurality of leads each including an inner terminal portion and an outer terminal portion integral with each other are mounted on a semiconductor chip. Accordingly, the present invention makes it possible to achieve a miniaturization of semiconductor devices. In accordance with the present invention, it is also possible to fabricate a resin encapsulated semiconductor device having an increased number of pins.

#### [EMBODIMENTS]

Hereinafter, embodiments of the present invention associated with resin encapsulated semiconductor devices will be described in conjunction with the annexed drawings.

Fig. 1A is a cross-sectional view schematically

illustrating a resin encapsulated semiconductor device according to an embodiment of the present invention. Fig. 1B is a perspective view illustrating an essential part of the resin encapsulated semiconductor device. Figs. 1A and 5 1B, the reference numeral 100 denotes the resin encapsulated semiconductor device, 101 a semiconductor chip, 102 leads, 102A inner terminal portions, 102B outer terminal portions, 102C connecting lead portions, 101A contacts (pads), 103 wires, 104 an insulating adhesive, 105 a resin encapsulate, 106 outer electrodes made of solder (paste), respectively. The resin encapsulated semiconductor device according to this embodiment is fabricated using a lead frame which will be described hereinafter. In this resin encapsulated semiconductor device, a plurality of L-shaped leads 102, each of which has an inner terminal portion 102A and an outer terminal portion 102 integral with each other, are mounted on a semiconductor chip 101 by means of an insulating adhesive 104. An outer electrode 106, which is made of solder, is 20 attached to each outer terminal portion 102B. The outer electrode 106 is outwardly protruded from a resin encapsulate 105. The resin encapsulated semiconductor device configured as mentioned above has a package area substantially equal to the entire area thereof. When this 25 semiconductor device is mounted on a circuit board, the

solder is melted and then solidified to allow the outer terminal portions 102B to be electrically connected to an external circuit. In the resin encapsulated semiconductor device according to the illustrated embodiment, contacts (pads) 101A provided at the semiconductor chip 101 are arranged in pairs along a center line L of the semiconductor chip 101 at opposite sides of the center line L in such a fashion that contacts included in each contact pair face each other. The outer terminal portion 102B of each lead is spaced apart from the inner terminal portion 102A of the lead. Between the inner and outer terminal portions 102A and 102B, a connecting lead portion 102C is interposed. The connecting lead portion 102C of each lead is bent in a direction orthogonal to the major surface of the semiconductor chip at a position near an associated one of the side surfaces of the semiconductor chip 101, so that it has an L shape. In each lead, the outer terminal portion 102B is arranged at an end of the connecting lead portion 102C. The outer terminal portions 102B of the leads are arranged in a one-dimensional fashion on a plane parallel to the major surface of the semiconductor chip 101. That is, the outer terminal portions 102B are arranged in two lines at opposite sides of the center line L. As mentioned above, one outer electrode 106 made of solder is connected to the outer terminal portion 102B of



each lead and outwardly exposed from the resin encapsulate  
105.

For the insulating adhesive 104, a polyimide-based thermoplastic adhesive having a thickness of 100  $\mu\text{m}$  (HM122C manufactured by Hitachi Chemical Co., Ltd.) is preferably  
5 used. Alternatively, a silicon denaturalized polyimide adhesive (ITA1715 manufactured by Sumitomo Bakelite Co., Ltd.) or a thermosetting adhesive (HG5200 manufactured by Tomoekawa Papermaking Co., Ltd.) may be used. Although  
10 outer electrodes made of solder paste are used in the illustrated embodiment, solder balls may be used.

As mentioned above, the resin encapsulated semiconductor device according to the illustrated embodiment has a package area substantially equal to the  
15 entire area thereof. That is, the illustrated embodiment of the present invention provides a package having a compact structure in regard to area. In accordance with the present invention, a thinned package structure can also be provided in that it is also possible to reduce the  
20 package thickness to about 1.0 mm or less. Although the outer electrodes have been described as being arranged in two lines along the contacts (pads) of the semiconductor chip, they may be arranged in a two-dimensional fashion. This is achieved by arranging contacts of the semiconductor  
25 chip in a two-dimensional fashion. On the surface of the

semiconductor chip arranged with those contacts, a plurality of terminal sets each having an inner terminal and outer terminal integral with each other are arranged in a two-dimensional fashion. In this case, it is possible to fabricate a semiconductor device using a semiconductor chip with an increased number of pins.

An embodiment of the present invention associated with a lead frame will now be described. The lead frame according to this embodiment is adapted to be used in the above mentioned semiconductor device. Fig. 2 is a plan view of the lead frame according to this embodiment. In Fig. 2, the reference numeral 200 denotes a lead frame, 201 inner terminal portions, 202 outer terminal portions, 203 connecting lead portions, 204 a connecting portion, and 205 an outer frame portion, respectively. The lead frame is made of 42 ALLOY (namely, an Fe alloy containing 42% Ni). The lead frame has a thickness of 0.05 mm at its thinner portion, that is, the inner terminal portions, and a thickness of 0.2 mm at its thicker portion, that is, the outer terminal portions. The connecting portion, which connects facing tips of the inner terminal portions to each other, has a thickness of 0.05 mm corresponding to that of the thinner portion. This connecting portion has a structure capable of allowing an easy punching thereof in the fabrication of the semiconductor device, as described

hereinafter. Although the outer terminal portions 202 have a ball shape in the illustrated embodiment, they are not limited to this shape. Also, although the lead frame has been described as being made of the 42 ALLOY, it is not limited to this material. For the lead frame, a copper-based alloy may be used.

Now, fabrication of the lead frame according to the illustrated embodiment will be described in brief. Fig. 4 illustrates a process for fabricating the lead frame according to the illustrated embodiment. First, a lead frame blank 300 having a thickness of 0.2 mm was prepared which is made of a 42 ALLOY (an Fe alloy containing 42% Ni). The prepared lead frame blank 300 was then subjected to a cleaning process, thereby removing grease from the surfaces thereof (Fig. 3a). Subsequently, photoresist films 301 were coated over both surfaces of the lead frame blank 300, respectively. The coated photoresist films 301 were then dried (Fig. 3b).

Using desired pattern plates, the photoresist films 301 on both surfaces of the lead frame blank 300 were exposed to light at their desired portions. A developing process was then conducted to the light-exposed photoresist films 301, thereby forming photoresist patterns 301A.

For the photoresist films, a negative liquid-phase resist (PMER resist) manufactured by Tokyo Ohka Co., Ltd.

was used. Using the resist patterns 301A as anti-etch films, the lead frame blank 300 was subjected to a spray etching process at both surfaces thereof. The spray etching process was conducted using a ferric chloride solution of 48 BAUME at 57 °C. Thus, a lead frame having a structure of Fig. 2a was obtained (Fig. 3d). Fig. 2a is a plan view of the lead frame. Fig. 2b is a cross-sectional view taken along the line A1 - A2 of Fig. 2a. Thereafter, the remaining photoresist thin films were peeled off. The resulting structure was then subjected to a cleaning process. A gold plating process was subsequently conducted for desired portions of the lead frame, that is, regions including inner terminal portions (Fig. 3e).

In the fabrication process of the lead frame, the etching process was conducted with a large etch depth at one major surface of the lead frame blank where outer terminal portions are to be formed, and with a small etch depth at the other major surface of the lead frame. In place of the gold plating, silver or palladium plating may be utilized. The above mentioned lead frame fabrication process is adapted to manufacture a single lead frame required for the manufacture of a single semiconductor device. In terms of productivity, however, the etching process is conducted for lead frame units each corresponding to the single lead frame shown in Fig. 2. To

this end, a frame member (not shown) is provided at a desired portion of the peripheral edge of the lead frame so as to connect a desired part of the outer frame portion 205 shown in Fig. 2 to a corresponding one of an adjacent lead frame.

Using the lead frame fabricated as mentioned above, the resin encapsulated semiconductor device according to the present invention was fabricated. Now, a method for fabricating the resin encapsulated semiconductor device in accordance with an embodiment of the present invention will be described. Fig. 4 illustrates the method for fabricating the resin encapsulated semiconductor device in accordance with the embodiment of the present invention. A polyimide-based thermosetting insulating adhesive (tape) 401 (HM122C manufactured by Hitachi Chemical Co., Ltd.) was applied to one surface, formed with the outer terminal portions 402, of the lead frame 400 fabricated as in Fig. 3 and the outer surface of the lead frame 400 using a hot pressing process conducted at 400 °C and 6 Kg/m<sup>2</sup> for 1.0 second (Fig. 4a). The resulting structure is shown in Fig. 5 which is a plan view. Thereafter, the connecting portions 403 connecting facing tips of the inner terminal portions were punched using punching dies 405A and 405B (Fig. 4b). Also, portions of the insulating adhesive

(tape) corresponding to those connecting portions 403 were punched (Fig. 4c).

Subsequently, unnecessary portions of the lead frame including the outer frame 404 were cut off using outer frame punching and pressing dies 406A and 406B (Fig. 4d).  
5 The lead frame was then bonded to a semiconductor chip 407 at its leads 410 under pressure while applying heat (Fig. 4e).

The process for cutting off the unnecessary portion of the lead frame including the outer frame 404 supporting the entire portion of the lead frame along with the connecting lead portion, as shown in Fig. 4d, may be carried out after an resin encapsulating process. In this case, dam bars (not shown) are preferably provided, as in  
10 QFP packages typically using a lead frame having a single layer structure. After the mounting of the leads 410 on the semiconductor chip 411, the inner terminal portion 410 of each lead 410 was electrically connected to an associated one of terminals (pads) 411A of the  
15 semiconductor chip 411 (Fig. 4f).  
20

Subsequently, an epoxy-based resin 415 was molded to encapsulate the resulting structure while exposing the outer terminal portions 410B of the leads 410 using a desired mold (Fig. 4g).

Although a specific mold (not shown) was used for the above process in the illustrated case, use of such a die may be unnecessary in so far as the resin encapsulating process can be conducted under the condition in which  
5 desired portions (outer terminal portions) of the lead frame are left. Thereafter, a solder paste was coated on the exposed outer terminal portions 410B in accordance with a screen printing process, thereby forming outer electrodes  
416 made of solder (paste). Thus, the fabrication of the  
10 resin encapsulated semiconductor device according to the present invention was achieved (Fig. 4h).

Although the formation of the outer electrodes 416 made of solder has been described as being achieved using a screen printing process, it may be achieved using a reflow  
15 or bonding process in so far as an amount of solder required for a connection of the semiconductor device to a circuit board is obtained.

#### (EFFECTS OF THE INVENTION)

20 As apparent from the above description, the present invention makes it possible to increase the occupancy degree of a semiconductor chip in a semiconductor package in situations requiring new resin encapsulated  
semiconductor devices having a highly integrated structure  
25 while exhibiting a high performance. The present invention

also makes it possible to reduce the area of the semiconductor device on a circuit board in order to cope with a compactness of the semiconductor device. That is, the present invention can provide a semiconductor device  
5 capable of achieving an improvement in the mounting density on a circuit board. At the same time, the present invention can provide a resin encapsulated semiconductor device having a new multipinned structure which could not be realized in compact packages such as conventional TSOPs.